A FIELD MANUAL
for the
HABITAT PROTOCOLS
of the
UPPER COLUMBIA
MONITORING STRATEGY

DRAFT: 2007 Working Version

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Section 1: Introduction

This document was created as an internal guide for field practitioners working within Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program (ISEMP). This draft document has been updated and revised for the 2007 field season. The ISEMP program has taken an experimental approach to the development of scientific monitoring protocols. Hence, this document is best viewed as a working draft that is subject to change as the ISEMP program adds, subtracts, or modifies portions of these methods. Changes to methods are adopted at the beginning of the field season and adhered to until the next year's manual is completed. However, because another purpose for this document is to prepare for the development of a final field manual when ISEMP is ready to propose standardized monitoring program elements, this manual also serves as a draft template for future ISEMP field manuals.

The habitat methods recommended by the Draft Upper Columbia Monitoring Strategy (Hillman 2006) are intended to measure biological and physical/environmental indicators and have been performed by field practitioners in the Upper Columbia Basin since 2003. This field manual is based primarily upon procedures and modifications of procedures from the EPA (Peck et al. 2001), and the Aquatic and Riparian Effectiveness Monitoring Plan program (AREMP 2005).

This field manual also incorporates into these procedures knowledge gained from practical field experience and experimentation carried out since the inception of the Upper Columbia Basin Monitoring Strategy (UCBMS). In 2005, the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) compared methods from different habitat protocols used throughout the region against each other and "truth", which was established through intensive surveys. Data metrics of each protocol were evaluated for comparability between protocols using the signal-to-noise ratio between crews using the same protocol at the same stream, the signal-to-noise ratio of different protocols measuring the same attribute at the same stream, and the ability for the measurements made under each protocol to ascertain the 'truth'. Although changes to this protocol are a likely result of this study they cannot be incorporated until specific recommendations from the PNAMP study are made final. However, measurements of flood prone width used to calculate entrenchment ratios were dropped from this protocol beginning in 2006 based upon PNAMP's preliminary results indicating the inability of any protocol tested to satisfactorily calculate entrenchment ratios. Preliminary results from the PNAMP study also showed that pools were best represented by the Northwest Indian Fisheries Commission (NWIFC) protocol derived from Pleus et al. (1999), which limited pools to those that meet a minimum pool area and residual depth based on the stream's bankfull width. The NWIFC divided pools into primary pools that are greater than 50% of the wetted width and secondary pools that are less than 50% of the wetted width. Secondary pools will be counted by ISEMP in 2007. Minimum pool criteria based upon bankfull width used by the NWIFC for primary pools can be applied to ISEMP data during the analysis phase if a between protocol comparison is desired, otherwise pools are counted the same as previous years to allow for between year comparisons of untreated data.

A separate study (Sennatt et al., 2006) compared the ability of five different protocols to detect embeddedness in the dam-controlled Ompompanoosuc River and found that the Peck et al. (2001) method (referred to in the study as the EPA method) adopted by ISEMP most effectively captures the expected impact of flow regulation on embeddedness in the Ompompanoosuc River. Additionally, it was the only method able to detect the translation of the region of low embeddedness downstream of the dam during the study period.

Changes to the 2007 protocol include the addition of the Data Management Section (Section 7) added to ensure data collected by this protocol meets the objectives of the ISEMP Data Management effort designed to develop standardized tools and procedures for the organization, reduction, and communication of monitoring data and methods within ISEMP pilot basins. The Habitat/Fish Abundance Section (Section 6) was added to give direction on how best to work with fish surveying crews to ensure that data from the habitat collections and fish abundance counts can be reliably integrated to assess fish densities at these sites. An Attribute Table derived from ISEMP's Aquatic Resource Schema (ARS) and Protocol Manager (PM) has been included as Appendix A. Data forms have been redesigned to reflect the structure of the ARS and the PM (Appendix B). Also new to the 2007 manual is a detailed description of how to 'follow the thalweg' when laying out sites. Separate monumenting methods were developed for status and trend sites, with status sites monumented only at the X-site, and trend sites monumented at the X-site, and transects A and K. Side pools were redefined to include alcoves, which were previously not well defined and difficult to identify in the field. The Macroinvertebrate Sampling section (Section 3) was expanded to meet the criteria established by PNAMP (2006). For the 2007 field season the crest depth at dammed pools will be measured at the tail and head.

This manual is designed for quick reference in the field, and is arranged in the order that crews would be generally expected to follow. Detailed descriptions of how to measure indicators have been included to reduce observer variation. It is appropriate to use this manual when performing status/trend monitoring or effectiveness monitoring in the Upper Columbia Basin, although study design requirements for specific effectiveness monitoring projects may require that aspects of these protocols be modified.

Section 2: Stream Site Lay Out

References:

Protocol is modified from Peck et al. (2001) and AREMP (2001, 2005).

Equipment:

Applicable maps, metric tape measure, stadia rod, handheld GPS device, digital camera, 3 2-foot long pieces of rebar or orange plastic survey stakes, hammer, engineer flagging, waterproof datasheets and notebook, mechanical pencils and waterproof markers.

Concept:

The biological and physical/environmental indicators identified by the UCBMS (Hillman 2006) require sampling a certain proportion of stream to obtain a representative picture of the ecological conditions in the whole stream network. Probalistically-based random sampling is used to ensure that the results from sampled sites can be generalized to the entire stream network. To ensure that sites are selected without bias, a generalized random tessellation stratified (GRTS) design is used for status/trend monitoring, whereas other designs may be used for effectiveness monitoring depending on specific study needs. The GRTS process generates a sample of “X-sites” located on the stream network. Habitat surveys, conducted over a specified stream reach, are meant to characterize conditions at these X-sites.

Trend monitoring is designed to describe current conditions and detect changes to the habitat that occur over time. This is complicated by the fact that changes in stream conditions may result in bankfull widths that are different than when they were first surveyed, or bankfull widths may be the same, but the site lengths may change as a result of a reconnected oxbow or straightening of the channel. Consequently, changes detected in the metrics collected may be the result of a different site length rather than an actual change for that metric. This poses a significant challenge of how to collect data that are comparable to past surveys while at the same time capturing changes to the reach that may have resulted in a different channel length or bankfull widths. Practitioners and strategy designers met in November 2006 and that decided trend sites (i.e. annual panel sites) will be laid out according to the site length established at the initial survey and will not change because of changes in bankfull width or changes in channel configuration.

Procedure:

Step 1: Use topographical maps and the GPS unit to find the approximate location of the site from the road, from where crewmembers can access the stream. Use the GPS to navigate to the assigned lat/long. If returning to an “annual panel” site, proceed to step 2. If the site is a “rotating panel” site or “annual panel” site surveyed for the first time use the GPS to find the closest point along the stream that corresponds to the GPS reading. This is the “X-site”. Find a suitable area along the X-site above bankfull to place a rebar monument. Record this location on the map. Record the Habitat Event Code (HEC) on the Stream Verification & Monument Form. The HEC includes the study design number followed by a dash, the site ID followed by a dash, the date followed by a dash, and lastly the time the survey was started using 24 hour time (see example below). Next, take a GPS position; label the GPS point using the HEC. If the GPS unit does not allow entry of the HEC, use an abbreviated code that can be replaced with the HEC at a later time. Include detailed notes of the code on the cover and map datasheet. Proceed with lay out on step 3.

> EXAMPLE: If the study design is WC503432, the site ID is 040619, the date is August 31, 2006, and the start time is 1:30 pm; then the HEC would read WC503432-040619-20060831-1330.

Step 2: When returning to an "annual panel" site locate the X-site and determine what transect the X-site is, usually the F-transect. Locate the A and K transects monuments. Using the site length from the previous survey, determine the distance between transects. Starting at A, X, or K, begin laying out the site, marking primary and secondary transects with flagging. If the transects do not align with the permanently monumented transects, make small adjustments to each transect until all transects are equally spaced between transects A and K. If the monuments are missing or cannot be found, relocate the monuments based upon the presence of the found bearing trees or other monuments and the distance between transects, remonument the location following the directions in Step 6. After laying out the "annual panel" site, skip to step 7.

Step 3: When returning to a "rotating panel" site or surveying an "annual panel" site for the first time, establish the bankfull stage. In order to determine bankfull stage, crews should look at several indicators, including stain lines, changes in substrate, slope breaks, tops of point bars, permanent vegetation, and debris lines. Additional details on bankfull identification are included in Table 1 (Harrelson et al. 1994). Several indicators should be examined to properly determine bankfull height. Indicators should be more distinguishable at non-constrained reaches where, for example, tops of point bars, changes in substrate, and permanent vegetation may be the most reliable indicators. In constrained reaches, especially those with boulders and bedrock substrate, indicators may be difficult, if not impossible, to identify. Under these circumstances, the crew may have to depend on stain lines, or go up or downstream to find reliable indicators and follow these lines back to the transect. Recent large flood events that have exceeded bankfull height may make it difficult to find the correct indicators. If someone on the crew has experience at determining the bankfull level, he/she should consistently determine bankfull height. Find the average bankfull width by measuring the bankfull width at the X-site, and then proceed upstream the distance of the first bankfull width and measure the bankfull width again. Continue upstream the distance of the bankfull width measured at X-site and measure the bankfull width a third time. Take 2 more bankfull measurements downstream from the X-site in the same manner for a total of 5 bankfull measurements. Average the 5 bankfull measurements. Multiply the average bankfull width by 20 to obtain the reach length. Minimum and maximum reach length is 150 m and 500 m, respectively (any average bankfull less than 7.5 m will have a site length of 150 m, and any average bankfull greater than 25 m will have a site length of 500 m). Divide the reach length by 10 to determine the distance between primary transects. Divide the reach length by 20 to determine the distance between primary transects and intermediate transects.

EXAMPLE: If average bankfull width is 12.6 m, the calculated reach length would be 12.6 * 20 = 252 m. The distance between primary transects would be 25.2 m, and the distance between main and intermediate transects would be 12.6m.

Step 4: Determine if the site needs to be moved to avoid confluences with higher or lower order streams, lakes, reservoirs, waterfalls, or ponds. Do not adjust the reach to avoid man-made obstacles such as bridges, culverts, rip-rap, or channelization. Sample sites can be moved upstream or downstream, however, the X-site should not be moved and must be included within the site and at a primary transect.

Step 5: Starting at the X-site, measure downstream along the thalweg a distance of 1 average channel width using a tape measure or stadia rod (if the distance measured is not greater than the rod used to measure it) and mark this point with flagging. If the X-site and the F transect are the same then the next downstream transect is called E-1 (secondary transect are A-1, B-1, C-1, etc.). Continue measuring 1 channel width downstream and label the next transect E (primary transect are A, B, C, etc.). Continue this until you have measured 10 channel widths from the X-site and are at the beginning of the reach, or transect A (Figure 1). Return to the X-site and repeat the procedure moving upstream, and ending at transect K. If the X-site is not located at transect F, center the reach so that transect F is in the middle. If the site is shifted upstream or downstream and transect F will not be located at the X-site, determine which transect will be positioned at the X-site and label the flagging accordingly, also clearly note on the Verification Form and the map. Monument the X-site separately if it does not correspond with transect A or K. Set up the site so that one of the primary transects falls on the X-site, maintain sequential ordering of transects from A to K, and maintain transect F as the middle of the reach. To avoid disturbing the stream channel before sampling enter the channel to make measurements only when necessary.

Note: Measuring distances along the thalweg can vary highly between observers in part because these measurements are dependent on the length of the straight-line segments used to measure the sinuous thalweg. A crew that “bends” their tape more frequently to capture zigzags in the thalweg will end up with a site that has a shorter total length than a crew that “cuts corners” by skipping some zigzags. Because we cannot standardize the definitions of zigzags, or the absolute units at which “bending the tape” or “cutting corners” is acceptable, we hope to standardize thalweg measurements in the following manner:

For measuring distances along the thalweg, the increment of measurement (i.e. the straight-line distance between points on a taut tape, or the length at which a stadia rod is extended) will be standardized as the 1/20th of the site length determined in Step 3 of the Site Lay Out procedure. This measurement increment will be maintained throughout all thalweg measurements at the site regardless of whether this measurement increment ignores “obvious” zigzags or whether the site is very straight and a larger increment might seem appropriate. A rod should be used only if it is as long as the distances being measured, otherwise, use a tape pulled taut. If rods are used, they should be extended to the increment of measurement. In general, this increment of measurement will equal the site-averaged bankfull width but can vary depending on maximum and minimum site length criteria discussed in Step 3 of the Site Lay Out procedure.

Because the purpose of this exercise is to measure the thalweg distance, it stands that each end of this straight-line increment will be positioned in the thalweg when the measurement occurs. However, in practice, at larger stream sites it may be easier for the observers to stay closer to the margin of the stream. In such cases, it will be acceptable for the measurement to be made closer to the margin of the stream provided that the standardized increment of measurement is used and that the measuring tape or rod is oriented parallel to the imaginary straight line connecting the two points on the thalweg.

For example, if the average bankfull width is 8.5 m and a tape is used, one surveyor would hold the end of the tape in the thalweg at the X-site and the other surveyor would flag the next transect at the point where the tape stretches tight and intersects the thalweg at 8.5 m. Subsequent transects would be flagged at the same 8.5 m increment. Because most rods do not extend to 8.5 m, a rod would not be used in this case.

Small sites with a bankfull width of less than 7.5 m where the minimum reach length is applied are particularly difficult to lay out since the distance between transects is much greater than the bankfull width. When laying these sites out it is appropriate to make a “break” in the measurement between transects to avoid the rod crossing out of the bankfull channel and cutting the site short. Base the distance between breaks on the average bankfull width determined during layout. If the average bankfull width is 4.2 m, then make a break every 4.2 meters (or just one break between 7.5 m transects) when laying out the stream. A 1 m average bankfull width stream would break every meter or about 7 times between transects. Make as few breaks in the measurement as needed to keep the rod or tautly pulled tape within the active channel when measuring from transect thalweg to transect thalweg. Make breaks at the thalweg only. Be careful to maintain the same total length between transects regardless if breaks are made or not.

EXAMPLE: If transect K is located at the X-site, the entire site would be downstream of transect K. If the X-site is located at transect J, 1/10th of the site would be upstream of the X-site and 9/10th would be downstream.

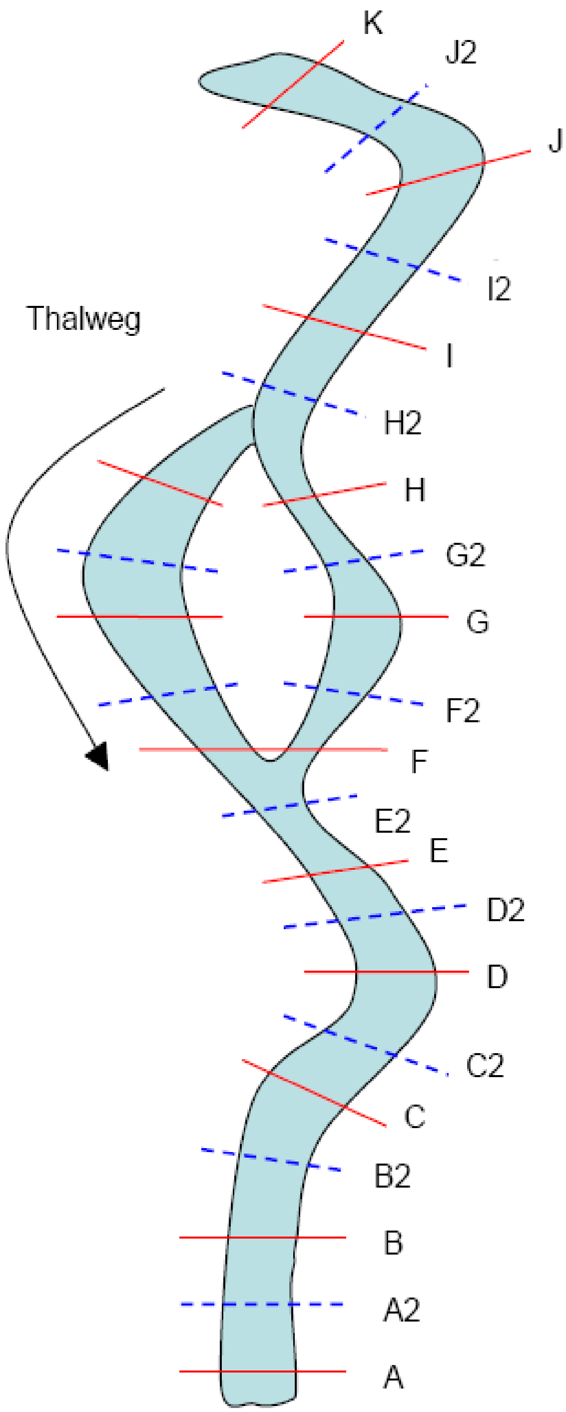
Step 6: While establishing transects A and K and the X-site record the latitude/longitude using the GPS, and on the Stream Verification & Monument Form. For status, or “rotating panel”, sites permanently monument only the X-site with 2- foot sections of rebar driven into the bank above the high water mark. For annual panel sites permanently monument the channel at transects A and K and the X-site with capped rebar. Do not place monuments on private property without permission to do so. This is an important step, as future crews will need to find this monument. If it is not possible to place a rebar as a monument, then lightly chisel “X-site, transect A or transect K” into a large, stable boulder or bedrock above the active channel, or drive a labeled spike into a tree that is in line with the transect (monument tree). When monumenting, establish a bearing tree on one bank, record its size and species, and securely nail a metal plate to the tree with the site ID, creek name, date, collectors, and transect recorded on it.

Take a bearing (with the declination set at zero) and measure the horizontal distance from the tree to the monument. Record these on the Stream Verification & Monument Form. Record this information on the metal tag and nail it to the bearing tree. Take GPS coordinates and photos at transects A and K, and the transect representing the X-site. Photos should be taken from the center of the channel and the sequence should begin with the center upstream shot (CU), and then the center left bank (CL), center downstream (CD), and center right bank (CR) shots. In addition, at the X-site photograph the bearing tree with the monument in the photo if possible. Record the photo number and the name of the camera on the Stream Verification & Monument Form.

> Note: When photos are downloaded they should be named according to the HEC followed by the transect, and lastly the orientation of the photo.
>
> Example: A photo taken at a Chiwawa River (HEC: WC503432-040619-20060831-1330) site from X-site transect looking from the center up would be named: WC503432-040619-20060831-1330_X_CU.

Step 7: Draw a map of the reach on the Map Drawing Form. Include the X-site, channel shape, presence of side channels, permanent monuments, primary transects, species and size of the bearing tree, a north arrow, and any major terraces and stream features (large pools, log jams, falls, etc.). A good map will shorten the time it takes to find the permanent monuments during resurveys, and allow future surveyors to ascertain if the channel has changed significantly.

Note: Permanent location of sites on private lands will be agreed upon with landowners. Minor modifications to the marking procedure may be necessitated by landowner requirements. Sites located in Wilderness where rules forbid placement of orange stakes will be monumented using discrete ground-level markers accompanied by aluminum flashing nailed into nearby trees.



Data collected at primary transects (red line):

- Bankfull and wetted width
- Bankfull height at right and left banks
- Depth, substrate, and embeddedness at 11 points
- Bar width (if present)
- Undercut distances at right and left banks (if present)
- Canopy cover measurements (densiometer)
- Visual riparian estimates for right and left banks
- In-channel fish cover assessment
- Human Influence assessment for right and left banks
- Percent unstable banks at right and left banks
- Permanently monument and record latitude/longitude in the GPS for transects A and K, and the X-site at "annual sites".
- Permanently monument and record latitude/longitude in the GPS for the X-site for "rotating panel sites".

Data collected at secondary transects (blue dash line):

- Bankfull and wetted width
- Substrate at 11 points
- Bar width (if present)

Data collected along thalweg profile (100 points):

- Thalweg depth
- Presence/absence of bars
- Presence/absence of side channels (regardless of flow)
- Presence/absence of in-channel habitat
- Instream habitat type
- Pool max and pool crest depth (if present)
- What formed the pool (if present)

Data collected in segments between primary transects:

- Large woody debris

Data Collected along whole reach

- Slope and bearing
- Macroinvertebrate samples

Figure 1. Reach lay out and data to be collected (modified from AREMP, 2005).

Table 1. Indicators used to determine bankfull stage of a reach (from Harrelson et al., 1994).

Indicator	Description
Top of Pointbars	The point bar consists of channel material deposited on the inside of meander bends. They are a prominent feature of C-type channels but may be absent in other types. Record the top elevation of pointbars as the lowest possible bankfull stage since this is the location where the floodplain is being constructed.
Change in Vegetation	Look for the low limit of perennial vegetation on the bank, or a sharp break in the density or type of vegetation. On surfaces lower than the floodplain, vegetation is either absent or annual. During a series of dry years, perennial plants may invade the formerly active floodplain. Catastrophic flows may likewise alter vegetation patterns. On the floodplain (above bankfull stage) vegetation may be perennial but is generally limited to typical stream side types. Willow, alder, or dogwood often forms lines near bankfull stage. The lower limit of mosses or lichens on rocks or banks, or a break from mosses to other plants, may help identify bankfull stage.
Change in Slope	Changes in slope occur often along the cross-section (e.g., from vertical to sloping, from sloping to vertical, or from vertical or sloping to flat at the floodplain level). The change from a vertical bank to a horizontal surface is the best identifier of the floodplain and bankfull stage, especially in low-gradient meandering streams. Many banks have multiple breaks, so examine banks at several sections of the selected reach for comparison. Slope breaks also mark the extent of stream terraces. Terraces are old floodplains that have been abandoned by a downcutting stream. They will generally have perennial vegetation, definite soil structure, and other features to distinguish them from the active floodplain. Most streams have three distinct terraces at about 2 to 4 feet, 7 to 10 feet, and 20 to 30 feet above the present stream. Avoid confusing the level of the lowers terrace with that of the floodplain; they may be close in elevation.
Change in Bank Materials	Any clear change in particle size may indicate the operation of different processes (e.g., coarse, scoured gravel moving as bed load in the active channel giving way to fine sand or silt deposited by overflow). Look for breaks from coarse, scoured, water-transported particles to a finer matrix that may exhibit some soil structure or movement. Changes in slope may also be associated with a change in particle size. Change need not necessarily be from coarse-to-fine material, but may be from fine-to-coarse.
Bank Undercuts	Look for bank sections where the perennial vegetation forms a dense root mat. Feel up beneath this root mat and estimate the upper extent of the undercut. This is usually slightly below bankfull stage. Bank undercuts are best used as indicators in steep channels lacking floodplains. Where a floodplain exists, the surface of the floodplain is a better indicator of bankfull stage than undercut banks that may also exist.
Stain Lines	Look for frequent inundation water lines on rocks. These may be marked by sediment or lichen. Stain lines are often left by lower, more frequent flows, so bankfull is at or above the highest stain line.

Section 3: Macroinvertebrate Sampling

Reference:

Peck et al. (2001), PNAMP (2006), Klemm et al. (2001), Gibson et al. (1996)

Equipment:

D frame kick net with 500-micron screens, clean container, ethanol, waterproof labels, a pencil, stopwatch, random number generator, and a bristle scrubber.

Procedure:

Macroinvertebrate sampling procedures follow the 8-ft^2 "targeted riffle" protocol for EMAP outlined by Klemm and others (2001), and the PNAMP protocol (PNAMP 2006). Aquatic macroinvertebrates are sampled after the site has been laid out. In order that the streambed is not disturbed before sampling begins, finish the site lay out and then, starting at transect A and proceeding upstream. The site composite sample comes from eight separate 1-ft^2 kick samples collected randomly from as many as eight separate riffles spread across the reach. Macroinvertebrate assemblages integrate stressor effects over the course of the year, and their seasonal cycles of abundance and taxa composition are fairly predictable within the limits of interannual variability (Gibson et al. 1996). Sampling and comparing data from the same season (or index period) as the previous year's sampling provides some correction and minimization of annual variability. The index period for the ISEMP 2007 invertebrate collection is from July 1st – September 30th.

Step 1: Examine the reach for riffle habitat. The goal is to collect the composite sample by distributing eight samples throughout the length of the site (from transects A to K). If there are eight or more separate riffles then sample eight riffles once throughout the site. If less than eight riffles are present in the reach, the crew should sample from four riffle habitats throughout the reach, collecting two samples from each riffle, being careful not to sample more than once from a single zone in a riffle (Figure 2). If less than four riffles are present then collect eight samples where riffle habitat is present. If the site does not have enough riffle area to collect all eight samples then collect as many as is possible in the riffle areas, and complete the sampling in non riffle habitat. Note on the Benthos Identification label what how much of each habitat type the composite sample was taken from. If there is not enough area to take a complete eight square foot sample (such as a dry site, or one inundated by deep, slow moving water), then note the total area sampled and the habitat type (riffle or non-riffle) on the Benthos Identification Form.

The sample location in each riffle is randomly selected from one out of nine possible zones in the riffle. Begin at the first riffle upstream from transect A, divide the riffle visually into nine zones (three zones extending upstream by three zones extending across the riffle). Exclude "margin" habitats by constraining the potential sampling area. Margin habitats are edges along the channel margins or upstream or downstream edges of the riffle. Avoid taking samples from deep, slow moving water.

Step 2: Place the kick net in the center of the visually located zone selected in Step 1. Ensure that the net is placed firmly on the surface so that there is no open space below the net. Have the recorder hold and secure the net in place, or if sampling alone, secure the net with knees or feet. Remove and carefully scrub the entire surface of any easily moveable rocks larger than a golf ball so that all the macroinvertebrates flow into the net. Visually check the rocks to ensure that all the macroinvertebrates are removed. Once the rocks are clean, place them outside the sampling area. Next, kick a 1- ft^2 area upstream of the net for 30 seconds, kicking toward the net. Make sure there is sufficient water flow through the net.

Step 3: Examine the contents of the net. Remove and scrub any rocks larger than golf balls that have entered the net. Continue sampling upstream until 8 square feet of riffle habitat are sampled across the reach. Once the net has picked up enough debris to impede further collection, empty the contents into a container and proceed upstream.

Step 4: Combine the eight kick samples into a single composite sample, and preserve in 95% ethanol (final concentration not less than 70% ethanol). When emptying net into composite bucket make sure to inspect the sides of net for smaller specimens and, if needed, use tweezers to remove them from net.

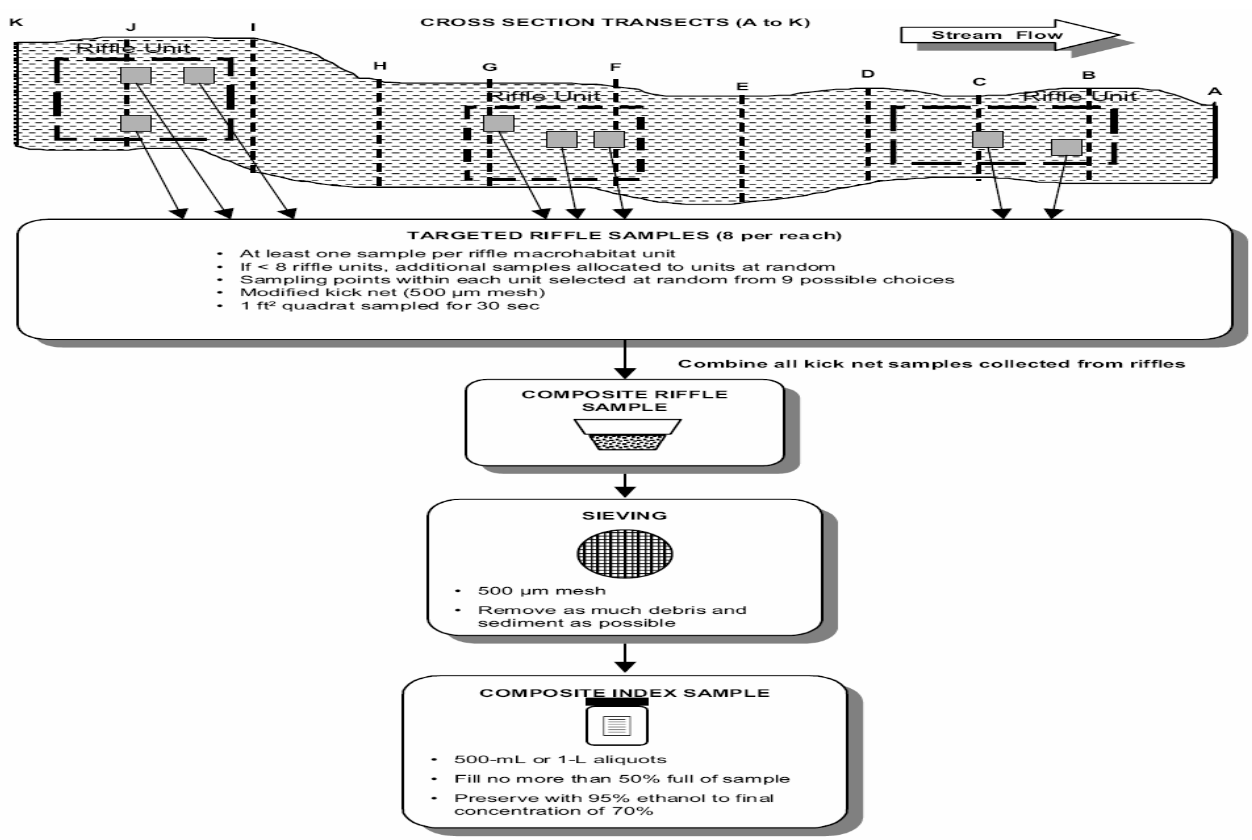


Figure 2. Sample design for benthic macroinvertebrates illustrating kick locations in visually located zones of a single riffle habitat (from Peck et. al., 2001).

Step 5: Using a pencil complete a benthos Identification label and place in the sample container (**Figure 3**3). Sample id tags are write-in-the-rain tags that include the HEC, the project name, the stream name, the collector, the total area of the sample, and if the sample includes non riffle habitat make a note under the collector's notes line. Close the container and write the HEC, the project name, the stream name, and the collector on the lid.

Step 6: In the laboratory, at least 500 benthic macroinvertebrates should be sorted out of each composite sample in a random systematic fashion. The macroinvertebrates will be identified to the lowest practical level, (typically genus) as found on the "Standard Taxonomic list for the Northwest," recommended by the Pacific Northwest Taxonomic Workgroup.

Figure 3. Example of a benthos identification tag used in macroinvertebrate collections.

BENTHOS IDENTIFICATION
HEC: *WC503432-040619-20060831-1330*
Project: *ISEMP*
Stream: *Chiwawa River*
Collector(s): *J. Doe*
Sample size: *8 sq. ft.*
Sample Habitat: *Two riffles present. Sampled 6 square feet from riffles and 2 square feet non riffle habitat*
Collectors Notes: *Not enough riffle present for complete riffle sample. Sample includes 2 square feet of non riffle habitat*

Section 4: Channel Form and Habitat Measurements

Channel cross-section measurements provide insight on the relationships of width and depth, streambed and stream bank shape, and bankfull. Several indicators are measured using longitudinal profiles, including gradient, sinuosity, the bankfull width to depth ratio, and pool frequency. These indicators are important attributes of channel condition and measures of the health of aquatic and riparian ecosystems.

I. Slope and Bearing Measurements

References:

Methods modified from Peck et al. (2001); Stack (1989); Robison and Kaufmann (1994); and Kaufmann et al. (1999).

Equipment:

Stadia rod, graduated 1.5 m monopod, hand level with 5x magnification, and compass. It is not recommended to use a hand held laser for slope measurements.

Procedure:

Crews will measure slope between primary transects so that there is a slope associated with each primary transect segment. Additional slopes at secondary transects may be taken if necessary. Further slope measurements can be taken if necessary, however, additional information is required if slope is not taken between transects.

Step 1: One crewperson stands at transect K and holds the hand level at a comfortable position against the stadia rod. Note the height at which the hand level is placed on the stadia rod and record it as eye height on the Slope and Bearing Form. Hold the bottom of the stadia rod at the water surface, usually at the stream's edge or on a rock placed at the water surface elevation. If it is necessary to place the stadia rod in the water, record the depth on the Slope and Bearing Form under the level wetted depth column.

Note: Do not use the measurement of your eye height while standing; always place the hand level at a recorded eye height on a stadia rod or other graduated rod.

Step 2*:* The second crewperson positions their stadia rod at the water surface elevation at the next primary transect or, if necessary, the secondary transect downstream. It is acceptable to skip secondary transects when measuring slope if the next transect is clearly visible and slope measurements are reliable. Whenever possible, place the stadia rod on a solid substrate at the water surface level; when possible avoid placing it on your boot or holding it at the water surface. If the two crew members are not visible to one another, then the downstream stadia rod should move up to a point where they are visible, preferably at a secondary transect. If added measurements are needed that do not correspond to a transect, measure and record the distance from the next upstream transect and fill out the extra measurements on the datasheet.

Step 3: With the downstream crewperson holding the stadia rod at the water surface level, the upstream crewperson uses the hand level to locate the position on the downstream stadia rod that is level with their eye. When shooting long distances it is helpful if the downstream person moves a finger up the rod to assist in reading the stadia rod. Take extra care to make sure the hand level and the stadia rod is in an upright position. Record the measurement under the level height on rod column of the Slope and Bearing Form.

Step 4: Looking downstream from the center of the stream (thalweg) with both shoulders perpendicular to the channel, take a bearing measurement with the compass. Do these at the secondary and primary transects. Be sure that the declination of the compass is set to zero, and that there is no electromagnetic interference that may affect the compass dial. The presence of even small pieces of metal near the compass can affect the bearing reading. Check for electromagnetic interference by moving the compass away from you while watching the movement on the dial. It is also possible to have erratic bearing measurements from interferences created by the substrate or old metal in the stream. Record the bearing on the Slope and Bearing Form.

Step 5: The crewperson with the hand level should proceed downstream, to where the other crewperson is holding the stadia rod. Place the hand level rod at the exact position where the stadia rod was, and the crewperson with the stadia rod moves downstream to the next primary. Repeat the slope and bearing measurements, making the last bearing measurement at secondary transect A. Check the data routinely with the transect you are at to confirm that no transect has been skipped or accidentally repeated. Limit the disturbance to the channel as much as possible while moving downstream.

II. Primary Cross-sectional Transects

References:

Methods modified from Kaufmann and Robison (1998), Peck et al. (2001), and AREMP (2005).

Equipment:

Two stadia rods, laser level, 50 m tape, high-tension clips, metric ruler, and a mechanical pencil.

Procedure:

Cross-sectional data are collected at all primary transects. To maximize efficiency, the surveyor calls out depth, and substrate class size and embeddedness as he/she crosses the channel, while the recorder estimates riparian cover and assesses fish cover and human disturbance. Also, the surveyor should take densiometer readings at the left and right banks and in the center of the channel as he/she moves across the channel collecting data. It may be useful to have the surveyor estimate canopy structure on the bank opposite to the position of the recorder.

Step 1: Begin each cross-sectional survey by determining the bankfull height of the channel on the right or left bank. Measure the bankfull height by placing the stadia rod at the wetted edge. Next, place the laser level or eye level against the stadia rod pointing toward the bankfull level. Level the laser level or eye level using its bubble indicator. Move the level up and down against the rod to line it up with the major bankfull indicators. With the level aligned with the bankfull indicators and level, record the bankfull height and move on to Step 2. After the surveyor has reached the opposite bank as part of Step 2, repeat Step 1. The recorder should average these two readings and record the average in the Ave. BFH field on the Primary Substrate Cross Sectional Data Form.

> Note: If one bank does not have reliable bankfull indicators leave the bankfull height field for that bank blank and use the other bank as the bankfull height for the transect bankfull height.

Step 2: Beginning at transect A, the surveyor pulls the tape or stadia rod across the channel with the recorder holding the other end and measures the bankfull width and wetted width of the channel. The recorder notes the values and reels in the tape. Also measure the undercut distance of any undercut banks and record it to the nearest 0.1 m. Because of undercuts sometimes the bankfull width will be less than the wetted width. Record the wetted width including any bars; also separately record the width of mid-channel bars under the Bar Width field.

> Note: Mid-channel and point bars are features below the bankfull flow mark, and islands are mid-channel features that are above the bankfull level. Treat a stream separated by an island as a main channel with a separate side channel. If the side channels have between 16% and 49% of the channel flow, then sample the side channel as its own transect in line with the main channel transect. When sampling side channels, complete only the Transectional Data Form and be sure to fill out the Side Channel Transect field at the top of the form. Braided streams have many bars but are considered one channel if none of the bars is above bankfull.

> Note: Measure the wetted width across the entire channel regardless if there is a mid-channel or point bar interrupting the wetted width measurement. Then measure the mid-channel or point bar in the transect and record it. Only measure a point bar distance if the wetted channel at the transect occupies both sides of the point bar. If more than one bar is in the channel then enter the total bar width and make a note that there were multiple bars present at the transect.

Step 3: With the surveyor and recorder still on opposite banks, divide the bankfull channel width into tenths to locate depth and substrate measurement points. Place the stadia rod at the bankfull height position, measure and record the bankfull depth or wetted depth.

> Note: Depth measurements at the left and right banks may be zero if the banks are not vertical.

> Note: Depth measurements that are out of the wetted channel require special attention. Since there is no water to take a depth measurement it is necessary to measure the

bankfull depth at that point by aligning the laser with bankfull indicators against the stadia rod. Be sure to record this measurement under the bankfull depth field. The wetted depth field is left blank. If bankfull indicators are not readily available it may be necessary to measure the elevation difference of the point on the dry channel bed and the water level. To do this place the stadia rod at the water level and place the laser level at the point to be measured. Point the laser to the stadia rod and record the difference as a negative value in the wetted depth field. Subtract it from the bankfull height to determine the bankfull depth for that point. Flag these measurements with a B if bankfull indicators were used to measure the depth at that point, or a W if the difference between that point and the wetted elevation was used. No flag is necessary for depth measurements taken in the wetted channel or at the bankfull height.

Step 4: Concurrent with the depth measurement, determine the embeddedness of the substrate at the base of the stadia rod. Embeddedness is the fraction of a particle's surface that is surrounded by (embedded in) fine sediments (≤ 2 mm) on the stream bottom. Sand and finer substrates are defined as 100% embedded. If the particle is fine or coarse gravel place or visualize a 10 cm ring around the particle and estimate what percentage of the particle is buried by sand and fines. For cobble first estimate the embeddedness of that particle as it appears in place, then again by carefully picking it up and estimating what percentage of the rock was imbedded by sand and fines. This can be done by 'reading' the stain lines around the particle left by the sand and fines. Use both estimates to best determine the embeddedness of cobble. Do not confuse these stains for stain lines present from algae or water stains. Embeddedness should be estimated for small and large boulders by estimating the percentage of the particle that is embedded by sand and fines without removing them. This requires the measurer to visualize how far the boulders extend below the streambed. Embeddedness of bedrock is 0%.

Step 5: As the surveyor removes the rod to estimate embeddedness, they should reach down and, without looking, pick up the first substrate touched under the tip of the stadia rod. Estimate the size of this particle using its intermediate axis (B-axis) (Every substrate has a long A axis, an intermediate B axis, and a short C axis). Use the Substrate Size Class Codes to determine which code applies to that particle (Table 2). If a particle is near a size break on the class code chart, and embeddedness has already been estimated, it should be picked up and measured using a tape or stadia rod.

Note: Substrate class and percent embeddedness should be estimated concurrently. Do not remove a particle to estimate size unless embeddedness has already been estimated, or it has been picked up with the intent of determining embeddedness.

Step 6: Repeat Steps 3 through and 5 for the next station located 10%, 20%, 30%, 40%, etc. of the bankfull distance across the channel.

Note: It is good practice to be in the habit of taking cross-section measurements in the same manner every time. The surveyor and recorder should start on the right bank; the surveyor then crosses the channel to measure bankfull and wetted widths, and takes depths, substrate, embeddedness, and canopy cover measurements as he/she returns to the right bank. The surveyor should also estimate riparian makeup (Section 5) while on the left bank. If the surveyor follows this sequence, the trips across the channel are limited. However, the terrain present may demand that the data be collected in a different order.

Table 2. Substrate type, abbreviations and size class used for pebble counts.

Substrate type	Abbreviation	Size class	Description
Smooth bedrock	RS	>4000 mm	Smooth surface rock bigger than a car
Rough bedrock	RR	>4000 mm	Rough surface rock bigger than a car
Hardpan	HP	>4000 mm	Firm, consolidated fine substrate
Boulders	BL	>250 to 4000 mm	Basketball to car size
Cobbles	CB	>64 to 250 mm	Tennis ball to Basketball size
Coarse gravel	GC	>16 to 64 mm	Marble to tennis ball size
Fine gravel	GF	>2 to 16 mm	Ladybug to marble size
Sand	SA	>0.06 to 2 mm	Smaller than ladybug size, but visible as particles and gritty between fingers
Silt, clay, muck	FN	< 0.06 mm	Silt, clay, muck and not gritty between fingers
Wood	WD	Regardless of size	Wood and other organic particles
Other	OT	Regardless of size	Concrete, metal, tires, car bodies, etc.

III. Riparian Assessment

References:

Modified protocol from Kaufmann et al. (1999) and Peck et al. (2001)

Equipment:

Convex spherical densiometer.

Procedure:

Canopy cover over the stream is determined at each of the 11 main cross-section transects. A convex spherical densiometer (Model B) is used (Lemmon, 1957). Six measurements are obtained at each primary transect: one on each bank and four from the middle of the channel. Visual estimates of the riparian cover are also made at each transect.

Step 1: Take densiometer readings at each bank regardless of the wetted edge, and from the middle of the channel looking upstream, looking to the left bank, looking to the right bank, and looking downstream. Use a model B convex spherical densiometer (Lemmon 1957) with only 17 square grid intersections showing (**Error! Reference source not found.Figure 4**).

Hold the densiometer 0.3 m above the surface of the water level with your face reflected just below the apex of the taped “V”. Level the densiometer using the onboard bubble level. In this position, carefully read how many of the grid intersections are shaded, a number between 0 and 17. Record this value in the appropriate field on the Densiometer Form.

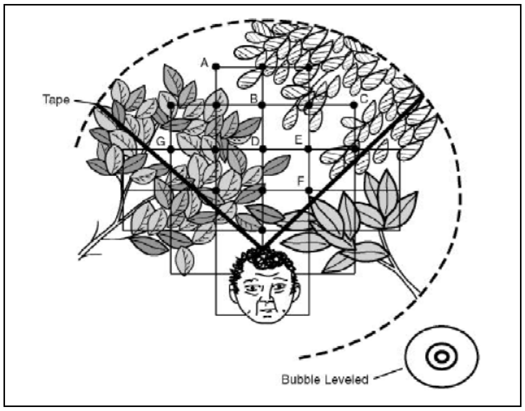


Figure 4. Schematic of modified convex spherical canopy densiometer (from Mulvey et al., 1992) showing 10 of 17 intersections with canopy cover, giving a densiometer reading of 10. Note proper positioning with the bubble leveled and face reflected at the apex of the "V".

Step 2: Visual riparian estimates should be made while taking the transectional measurements. Facing the bank, estimate a 5 m distance upstream and downstream from the primary transect (10 m total length). Estimate a distance of 10 m back into the riparian vegetation from the bankfull stage. Within this 10 m by 10 m square, visually divide the riparian vegetation into three layers: a canopy layer (>5 m high), an understory (0.5 to 5 m high), and a ground cover layer (<0.5 m high). Within this 10 m by 10 m area, determine the dominant vegetation type for the canopy layer and the understory as either deciduous (D), coniferous (C), broadleaf evergreen (E), mixed (M), or none (N). Record the appropriate vegetation type by writing the corresponding letter in the Riparian Visual Estimate field.

> Note: Consider the layer “mixed” if more than 10% of the aerial coverage is made up of the alternate vegetation type.

Step 3: Examine the canopy cover layer (> 5 m). Determine separately the aerial cover class of 1) large trees (>0.3 m diameter at breast height DBH), and 2) small trees (<0.3 m DBH). Estimate aerial cover as the amount of shadow that would be cast on the ground below it by a particular layer alone if the sun were directly overhead. Record the cover class by writing the appropriate number on the Riparian Visual Estimate Form. Cover classes are 0 (absent), 1 (< 10% cover), 2 (10-40% cover), 3 (40-75% cover), and 4 (>75% cover).

Step 4: Examine the understory layer (0.5 m to 5 m high). Using the same cover classes determine the aerial cover class separately for 1) woody shrubs and seedlings (including canopy tree stems within the height parameters of this class (0.5 m to 5 m high), and 2) non-woody herbs, forbs, and grasses.

Step 5: Examine the ground cover (ground level to 0.5 m). Determine the aerial cover class separately for 1) woody shrubs and saplings, 2) non-woody herbs/forbs/grasses, and 3) barren, bare dirt, or duff.

Step 6: Repeat Steps 2 through 7 for the opposite bank.

IV. Fish Cover

References:

Peck et al. (2001).

Equipment:

No special equipment needed.

Procedure:

Fish cover, algae, and aquatic macrophytes are assessed using a semi-quantitative visual estimate of the channel, extending 5 m upstream and downstream of each primary transect. Features that are visually estimated in this area include filamentous algae, aquatic macrophytes, woody debris (>0.3 m diameter), brush and small woody debris (<0.3 m diameter), overhanging vegetation (< 1 m above the water surface), undercut banks, boulders, and artificial structures. The recorder usually conducts this assessment as the surveyor surveys each primary transect.

Step 1: Examine the channel 5 m upstream and downstream of the transect. Within that area estimate the percent area of the wetted channel where each attribute provides cover for fish (i.e. where a fish could hide from a predator) as listed and defined in Table 3. Fish cover is not assessed for dry channels.

Step 2: Enter the appropriate the number from Table 4 in the Fish Cover Form representing the area covered in the wetted channel for each attribute.

Table 3. Definitions of elements that provide fish habitat and cover in the wetted channel.

Filamentous algae: Area of the channel effectively covered by long, streaming filaments of microscopic algal cells that often occur in slow moving, nutrient rich water with little riparian shading. Not to be confused with macrophytes and flowering aquatic plants that can look very much like algae when flower are not present.
Marcrophytes: Floating, submerged, or emergent water loving plants, including mosses and wetland grasses that could provide cover for fish or macroinvertebrates.

Large Woody debris (>0.3 m diameter): Larger pieces of wood that can influence cover and stream morphology.
Brush/small woody debris (<0.3 m diameter): Smaller wood that primarily affects cover but not morphology.
Live trees or roots: Area of the channel effectively covered by parts of trees, including roots that are in the active channel and are alive.
Overhanging vegetation: Area of the channel effectively covered by vegetation within 1 m of the surface water.
Undercut banks: Area of the wetted channel effectively covered by undercut banks. A channel is rarely covered more than 10% by undercut banks.
Boulders: Area of the channel covered by boulders between 25 cm and 4 m (b-axis).
Artificial structures: Area of the channel covered by artificial structures including those placed in the channel for fish restoration, structures discarded in stream (tires, old cars, etc.), or those placed in the stream for diversions, impoundments, channel stabilization, or other purposes.

Table 4. Percent of channel area covered by fish cover.

Fish cover descriptor	Fish cover class	Percent of wetted channel
Absent	0	0
Sparse	1	<10
Moderate	2	10-40
Heavy	3	40-75
Very Heavy	4	>75

V. Human Influences

References:

Protocol modified from Peck et al. (2001)

Equipment:

No special equipment needed.

Procedure:

Step 1: Evaluate and record the presence and proximity of human influences on the Human Influence Form. Human influence observations are confined to 5 m upstream and 5 m downstream of each transect (Figure 5). The proximity of human influences is distinguished according to whether the activity is at the bank, close to the bank (within 10 m), or far from the bank (10 to 30 m from the bank). Assess human influence conditions 5 m upstream and 5 m downstream of the transect. There are 11 categories used to determine human influences at the transects:

- Walls/ dikes/ revetments
- Buildings
- Pavement
- Roads/railroads
- Pipes
- Landfills/trash
- Parks/lawns
- Row crops
- Pasture/range/hay fields
- Logging operations
- Mining activities.

Step 2: Record under the Human Influence Form if the human influence is at the bank (B), within 10 m of the bank (C), or more than 10 m from the bank (Pn) for the right and left banks at each primary transect.

Step 3: Next, estimate the percent of the bank that is unstable 5 m upstream and 5 m downstream of the transect. Active erosion is defined as recently eroding or collapsing banks and may have the following characteristics: exposed soils and inorganic material, evidence of tension cracks, active sloughing, or superficial vegetation that does not contribute to bank stability. Limit your observations of bank stability to the portion of the bank at and below the bankfull level. Record the percentage of the bank that is unstable for the right and left bank on the Human Influences Form.

Note: Unstable banks have breakdown, slumping, cracking or bare or steep surfaces.

Step 4: Repeat Steps 1 through 3 at each primary transect.

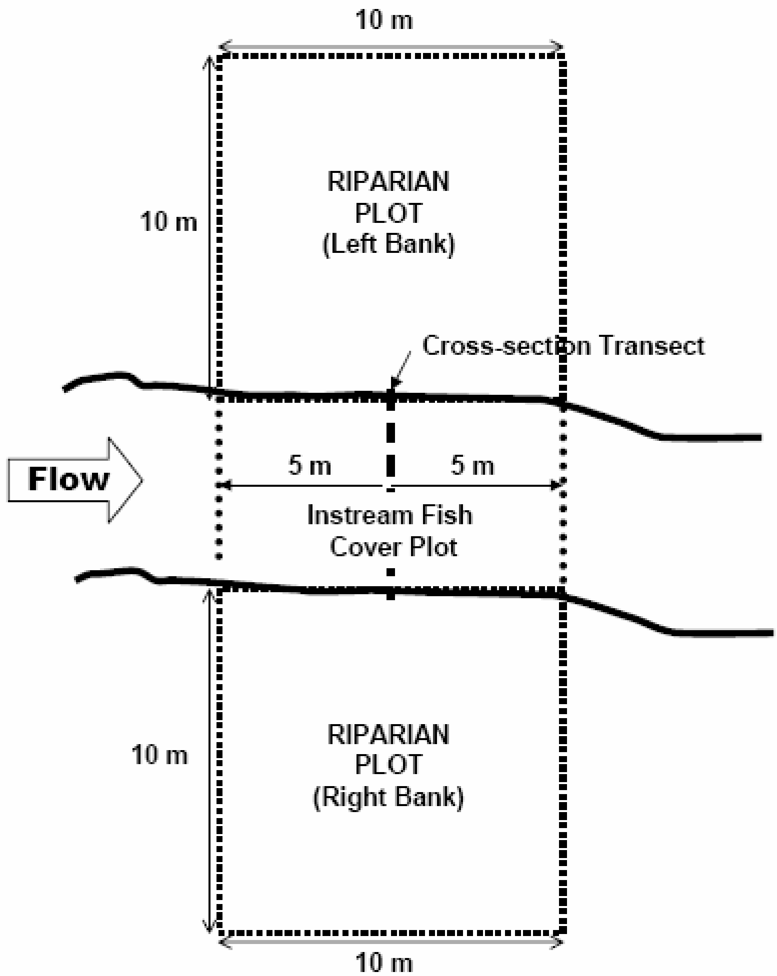


Figure 5. Boundaries for visual estimation of riparian vegetation, instream fish cover, and human influences (plan view). From Peck et al. (2001).

Section 5: Longitudinal (Thalweg) Profile &Woody Debris

I. Longitudinal Profile

References:

Protocol modified from Peck et al. (2001), and AREMP (2001 and 2005).

Equipment:

Stadia rod, 50 m tape, and laser level.

Procedure:

Longitudinal profiles are performed by following the thalweg of the main channel at 100 equally spaced stations. Habitat type, pool maximum and crest depth, presence of side channels, and in-channel habitat are assessed at each longitudinal point. For maximum efficiency the recorder should count the large woody debris (LWD, see below) while the surveyor moves up the longitudinal profile between transects. For streams with an abundance of LWD, it may be more efficient for the surveyor to call out the LWD totals to the recorder. Substrate is measured for size class at the secondary transects as part of the longitudinal profile.

Step 1: Determine the interval distance between thalweg measurements by dividing the total reach length into 100 stations based on the bankfull width used to determine the length of the sampling reach.

Step 2: The surveyor moves upstream the distance of the thalweg interval calculated in Step 1 and calls out a depth measurement in the thalweg of the channel to the recorder.

Step 3: At the thalweg station examine the stream to the right and left for the presence of side channels. Number and record the presence of side channels as they are encountered moving upstream regardless of flow. The side channel length only needs to be recorded once, write the side channel number and the length in the side channel length field. Number the side channels and continue to record their presence at each longitudinal point. In the case of multiple side channels be sure to clearly draw and record the length of side channels on the map.

> Note: If a side channel is present and contains between 16% and 49% of the total flow, establish side channel transects as necessary. Establish side channel transects in line with the primary transects but perpendicular to the side channel flow. Use separate field datasheets to record data for the side channel. Clearly identify and label all main channel and side channel transects in the Map Form. Side channel data collection is limited to the Transectional Data Form with no longitudinal or secondary transect data collected on the side channels. Do not rely on the increment length of the main channel to calculate the side channel lengths. It is better to actually measure and record all side channel lengths.

Step 4: Examine the channel at the thalweg and identify the appropriate habitat units that are present (see table 4). Habitat units are broken into three types: Turbulent, non-turbulent, and pools. Turbulent habitat tends to have broken, white-capped waves and is noisy. Non-turbulent habitat tends to not have whitecaps and is less noisy. Pools are slower, deeper water habitats that form a depression in the stream. Pools must meet the criteria listed under Table 5. Pools are considered Primary pools if they meet the pool criteria and are greater than half the wetted width, and are considered Secondary pools if they meet the pool criteria and are less than half the wetted width. Write a "P" or "S" under the Primary/Secondary fields in the Habitat Unit Form. Pool types are identified as scour (S), plunge (P), or dammed (D). Scour pools are generally created by fluvial processes and occur in a predictable manner along the stream where the power of the stream scours the stream bed into a pool. Plunge pools are formed by the water flowing over an object and scouring a depression in the stream as the water falls over that object. Dammed pools are formed when an object (usually wood) backs up the stream and forms a pool. Pools are further identified by the process or objects that created them (see table 4).

Determine the appropriate channel habitat unit code and pool forming element code (if applicable) for the station and enter the appropriate letter representing the habitat unit (Table 4). Indicate dry stations by checking the "dry" field for that station. If the habitat unit is a pool, measure and record the pools maximum depth and crest depth. For scour and plunge pools measure the crest depth at the tail of the pool. Dammed pools crest depth should be measured at the head and the tail of the pool. Peck et al. (2001) and the 2006 version of this protocol measured crest depth at the head of dammed pools[1]. Beginning in 2007 both the head and tail crest depths will be measured at dammed pools.

> Note: At stations where the thalweg is too deep to measure directly, stand in shallower water and extend the surveyor's rod, calibrated rod, or pole at an angle to reach the thalweg. Determine the rod angle by resting a clinometer or laser range finder on the upper surface of the rod and reading the angle on the external scale of the laser range finder. Leave the depth reading for the station blank, and record a "U" flag. Record the water level on the rod and the rod angle in the comments section of the field data form. Calculate and record the estimated depth. For even deeper depths, it is possible to use the same procedure with a taut string as the measuring device. Tie a weight to one end of a length of string or fishing line and then toss the weight into the deepest channel location. Draw the string up tight and measure the length of the line that is under water. Measure the string angle with the clinometer.

Examine the channel at the thalweg for the presence of backwater areas and side pools. Backwater habitats are areas of standing or slow moving water partially isolated from the flow of the main channel (Armentrout 1998). Side pools are deep, concave shaped areas that do not meet the definition of a primary pool and are adjacent to the stream channels and remain connected to the channel (Nickleson et al. 1992). Record the presence of backwater areas or side pools by sequentially numbering in the backwater and side pool fields. During the 2005 and

[1] Data collected in the Entiat Basin in 2006 measured dammed pools crest depth at the head and tail of the pool, and the tail crest depths was entered into the ISEMP database with the head crest added in the comment field.

2006 season alcoves and side pools were counted separately. Alcoves have not been adequately defined in the literature; however, Nickleson et al. (1992) describes alcoves and side pools similarly, differing only in where in the active channel they occur. Beginning in 2007, alcoves are considered as side pools regardless of where they occur in the channel.

> Note: If a dammed pool flows over a log measure the tail crest depth at the deepest flow. If there is no overflow (i.e. beaver dam) then the tail crest depth is 0.

> Note: It has been found that variance between crews using the same protocol to identify and measure habitat units in the same reach can be quite high (Roper and Scarnecchia 1995, Roper et al. 2002). To limit the variance between crews, crewpersons must be well trained, with the most experienced crewmember identifying habitats.

Table 4. Habitat types, definitions, and codes, and pool formation types and codes.

Habitat Type	Habitat Code	Pool Formed by	Pool Formation Code
Plunge Pool	P	Fluvial Processes	F
Scour Pool	S	Boulder or Bedrock	B
Dammed Pool	D	Rootwad	R
Turbulent Fast Water	T	Wood	W
Non-turbulent Fast Water	N	Not a Pool	N

Step 5: If a mid-channel bar is present, mark a “Y” for yes under the Bar Presence field.

Step 6: Use the stadia rod to measure the next thalweg point and repeat Steps 2 through 5. If the stream is split, follow the channel with the most flow.

> Note: Every 5th measurement should end at the next flagged secondary transect (A1, B1, C1… etc.). It may be necessary to make minor adjustments to align station 5.

Step 7: When the surveyor has reached station 5, take a wetted width and bankfull width measurement across the channel. If present, measure and record the bar width at station 5.

Step 8: Conduct a substrate pebble count at the secondary transects in the same manner as at the primary transects; however, do not estimate embeddedness or take depth measurements at the secondary transects. Record secondary transect substrate under the secondary transect substrate fields.

Step 9: Continue taking thalweg measurements upstream until station 9 is reached, one longitudinal increment below the next primary transect (A, B, C, etc.). Again, it may be necessary to make minor adjustments to the longitudinal station spacing so that station 9 is one increment short of the next transect.

Table 5. Criteria used to define pools.

Primary pool units must be wider than half of channel wetted width.
Secondary pool units are less than half the channel wetted width
All pool units must include the thalweg.
Pool units (except plunge) must be longer than wide.
All pool units must have a max. depth 1.5X the crest depth.
Crest depth is measured at the tail of pools except dammed pools where crest is measured at the tail and head.

II. Large Woody Debris Assessment

References:

Methods modified from Peck et al. (2001).

Equipment:

Measuring tape and meter stick.

Procedure:

These methods are used to tally LWD within the bankfull channel for the 10 segments of stream located between the 11 primary transects (A, B, C, etc.). Large woody debris tallies are separated into size length and diameter classes. The data recorder counts LWD as the surveyor measures thalweg depths between transects.

Step 1: Scan the stream segment between transects A and B.

Step 2: Tally all LWD pieces that are at least partially within the bankfull channel. LWD must have a large end diameter of at least 10 cm and a length of at least 1 m.

Step 3: For each piece of LWD, determine which of the nine classes it falls into based on the diameter of the large end and length of the piece (Table 6).

Note: If a piece is not cylindrical, visually estimate what the diameter would be for a piece of wood with a circular cross-section that would have the same volume.

Note: Wood that is imbedded within the stream bank is counted if the exposed portion meets the length and width requirements. Do not count a piece if only the roots (but not the stem/bole) extend within the active channel.

Step 4: Tally the number of pieces for each diameter and length class.

Step 5: After the LWD has been tallied for the transect segment, write the total number of pieces for each diameter and length class in the appropriate LWD size class field.

Step 6: Repeat Steps 1 through 6 for the next stream segment.

Table 6. Size classes used to categorize large woody debris.

Diameter classes	**Length classes**
•10 cm to 15 cm	• 1 m to 3 m
• >15 cm to 30 cm	• > 3 m to 6 m
•> 30 cm	• > 6 m

Section 6: Snorkel/Habitat Surveys

This protocol is designed to collect the habitat data necessary to determine fish abundance per area or per volume at sites where fish have been counted. A separate ISEMP protocol is currently under development for the 2007 field season for conducting snorkel surveys in conjunction with habitat surveys at ISEMP status/trend sites and effectiveness sites. This section describes aspects of that protocol that are pertinent to the habitat surveys.

Follow these guidelines when habitat surveys are followed by snorkel surveys in the Wenatchee and Entiat subbasins:

1. Initial site selection will be provided by the ISEMP staff[2]

2. Reconnaissance of sampling sites will be performed by an ISEMP designated "Recon Coordinator" from among those ISEMP agencies contracted to BPA. Prior to the field season, the Recon Coordinator will provide WDOE with directions for physical access and authorization for access to sites on federal lands.

3. Reconnaissance of sampling sites will be performed by Chelan County Conservation District (CCCD) on non-federal properties. Prior to the field season, CCCD will provide WDOE with directions for physical access and authorization from property owners for access to privately-owned sites.

4. All habitat surveys will be conducted prior to snorkel surveys and habitat crews will be responsible for reach lay out and monumenting.

5. Snorkel and habitat surveys should occur as close together as possible to minimize potential changes to the habitat over time. (e.g. seasonal flow changes, storm events, etc.).

6. Snorkel surveys will be restricted to the “site” defined by transects A and K.

7. WDOE and Recon/Snorkel Coordinator, or designated alternates, will confer weekly during the field season to discuss reconnaissance, site lay out, the previous week's progress, and to determine future sampling plans.

8. In the event that significant changes in sampling plans occur, WDOE and the Recon Coordinator, or designated alternates, will discuss in-person or by phone and prior to performing additional sampling, how to best proceed to ensure adequate coordination of snorkel and habitat surveys.

[2] A Site Selection Protocol is currently under development for the 2007 season for the ISEMP program that will give direction on how to select ISEMP sites.

Section 7: Effectiveness Monitoring Habitat Unit Survey

References:

Protocol developed for the Entiat Effectiveness Monitoring effort; portions of this protocol are based upon Pleus et al. (1999)

Equipment:

50 m tape and stadia rod.

Procedure:

These methods were developed to assist crews in measuring habitat units in conjunction with fish abundance surveys at Effectiveness Monitoring sites on the Entiat River in order that fish abundance per habitat unit area may be calculated and compared to control sites as well as between year comparisons of the same site as treatment efforts move forward. This data may be collected in conjunction with a complete habitat survey or on its own. Data collected for Effectiveness monitoring must include identification of habitat units and sub-units, wetted widths at each primary and secondary transect, lengths and average widths for each habitat unit, and crest depths and maximum depths for all pools units.

Step 1: Locate, monument, and layout the site according to the study design and/or instructions in Section 2.

Step 2: Beginning at transect A and proceeding upstream identify and number the habitat units. Place flagging to identify the beginning and ending of each unit in the reach. On the habitat survey form record with station each habitat unit occupies. It may be possible to have more than one unit associated with a station, number and record them in the order they are encountered.

> Note: Habitat units are defined as either pool or riffle. Pools can be secondary or primary, but must meet the criteria established in Section 5. All habitat units are assumed to be riffle unless proven otherwise. Riffles may be divided into sub units to meet objectives of the study design and to represent significant differences in riffle habitat (e.g. changes in slope, presence of instream structures, areas influenced by LWD, etc.). Extra habitat units may also be established in anticipation of proposed restoration activities. Consult the study design when establishing ‘extra’ habitat units.

Step 3: Establish and record the baseline length of each unit. If the habitat unit occupies at least two longitudinal station, the unit length can be calculated instead of measured by multiplying the number of stations it is associated with by the distance between stations (measure the length if calculating does not accurately represent the habitat unit shape). Each units beginning and ending is associated with a longitudinal station. If the habitat unit does not occupy at least two stations, the length must be measured. If the study design employs minimum site lengths, or the sites have complex or oddly shaped habitat units or secondary habitat units, it may be possible to have more than one habitat unit associated with a longitudinal station or habitat units not occupying a station at all. If a habitat unit does not occupy a station then record its presence with the previous station and measure and record in the notes the distance it begins or ends upstream from that station.

Step 4: Measure and record the width of each habitat unit. Width measurements are taken perpendicular to the thalweg at systematic intervals. If the habitat unit includes at least two transects and includes the entire wetted channel then wetted widths from transects can be used to determine average wetted width for the habitat unit, as long as they are representative of the unit. Still record these values under the Habitat Unit Width column. Widths should be measured at least 2 to 5 times for each habitat unit. Widths of more irregular habitat units should be measured more frequently than relatively straight and rectangular units. Strike a balance between accurately representing the average wetted width and the time required to make such measurements.

If a habitat unit requires more measurements than is collected at transects or the unit does not occupy the entire wetted channel, then take separate width measurements at longitudinal stations and record them under the HU Wetted Width box. For sites with irregular habitat units, or habitat units that do not occupy a longitudinal station, it may be necessary to collect supplemental wetted widths. Where primary and secondary units share a common wetted boundary crews should measure from the wetted edge to the common wetted boundary, and then from the common boundary to the opposite wetted edge. Primary units include 50% of the wetted channel width and secondary units are less than 50% or out of the main channel (such as an irrigation diversion). When measuring habitat units at longitudinal stations, subtract any bar width before entering the data under the Habitat Unit Width column. However, channel wetted width made at station 5 include bar widths and are recorded under the Wet Width column. Bar widths are recorded separately at primary transects and secondary transects.

Step 5: Additional information is collected for pool habitat units. Measure and record the maximum pool depth, crest depth(s), pool type, and pool-forming codes as detailed in Section 5.

Section 8: Data Management

The ISEMP Data Management effort is designed to develop standardized tools and procedures for the organization, reduction, and communication of monitoring data and methods within ISEMP pilot basins located in the Wenatchee, WA, John Day, OR, and Salmon River, ID basins. Beginning in 2004, a pilot project has been under development aimed at integrating three primary data management tools: the STEM Databank, Protocol Manager (PM), and the Aquatic Resources Schema (ARS). The STEM Databank is the central data repository for the ISEMP project. It was developed by the Scientific Data Management Team at NOAA-Fisheries to: (1) accommodate large volumes of data from multiple agencies and projects; (2) summarize data based on how, when, and where data were collected; (3) support a range of analytical methods; (4) develop a web-based data query and retrieval system, and (5) adapt to changing requirements. This fully-normalized database structure allows the incorporation of new attributes or removal of obsolete attributes without modification of the database structure. Data can be summarized in a variety of formats to meet most reporting and analytical requirements.

The Bureau of Reclamation and the National Park Service developed the Protocol Manager (PM) to describe data collection methods for all attributes and indicators collected by a project. PM tracks methods as the atomic unit of ecological metadata and defines protocols as a collection of methods. Data collection methods define or prescribe how data are to be collected in the field, include bibliographic references, and describe the set of attributes or data elements collected. Protocols consist of the set of methods used by a project during a given year. All values in the STEM Databank must be associated with a method from PM. This allows easy access to full metadata description of any value in the database and supports protocol comparisons, site comparisons, or analysis of functional relationships. Protocol Manager is being adopted by PNAMP as a data dictionary to prescribe standardized methods for field data collection and specifically define the data elements that represent habitat and biological variables. The ARS was developed to help standardize the information content and structure of new data being collected by ISEMP-funded data generators and to facilitate the migration into central data repositories. When entering data into the ISEMP data management system remember that protocols and data collection methods only enter through the Protocol Manager and ISEMP field data may only enter the ISEMP data management system through the ARS.

The field practitioners should be careful to avoid transposing errors when writing and entering data, and should be sure that all data are clearly legible. Practitioners should be in the practice of making photocopies of data sheets, and designating a copy as the Master Copy. The Master Copy can be edited by reviewers using red ink who should initialize and date any edits. Future copies of the Master Copy should either be made in color or clearly show these post-survey edits.

Section 9: Field Gear List

1. GPS unit with extra batteries
2. Appropriate maps including USGS 7.5 min.
3. Digital camera with extra batteries and memory
4. Two known working compass
5. Waterproof metal clipboard
6. Appropriate waterproof forms and field note books
7. Extra waterproof data forms
8. At least 3- two foot long ½ inch dia. rebar with caps
9. At least 3 metal bearing tree site ID tags
10. Sledge hammer and handful of 3" nails
11. Two 50 m tapes
12. Two 5 m or 7.5 m stadia rods
13. Clip on centimeter ruler
14. hand level and case
15. Orange and pink flagging
16. A bunch of sharpies and mechanical pencils
17. Laser level with extra batteries
18. Hip waters and felt boots
19. Emergency first aid kit
20. D-frame 500 micron kick net
21. Plastic bottles and ethanol for invertebrate samples
22. Scrub brush
23. Stop watch
24. Random number table
25. A couple of carbineer
26. A pack lunch and plenty of water
27. Polarized sunglasses
28. Sun blocker lotion
29. Sun hat
30. Good hiking boots and socks
31. Matches and firestarter
32. A copy of this protocol
33. A good back pack for all this stuff

Section 10: References

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Appendix A: Attribute Table

Appendix B: Dataforms